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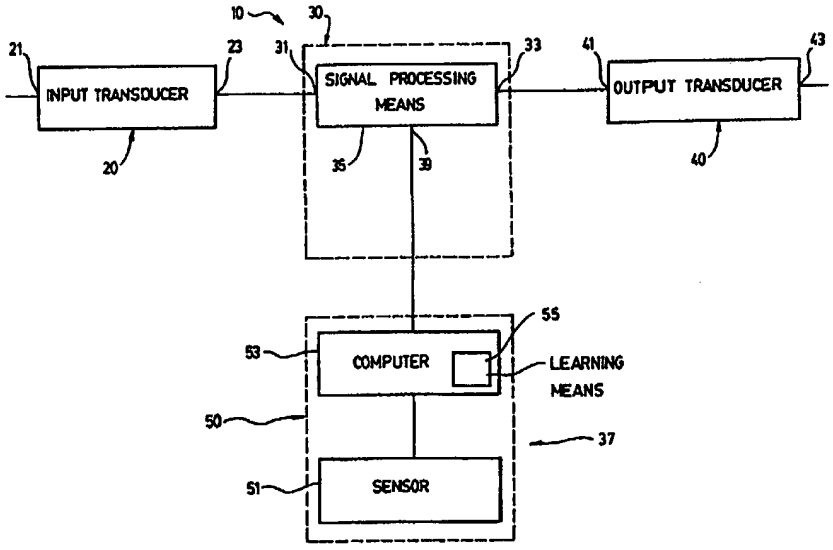
(54) Title: HEARING INSTRUMENT WITH HEAD ACTIVATED SWITCH

(57) Abstract

A hearing instrument has at least one input transducer having an input for receiving ambient signals and an output for generating a first electrical signal corresponding to the ambient signals, a programmable signal processor having at least one input for receiving and processing the electrical signal to produce a second electrical signal, a switch to switch the processor from one program to another, an output transducer having an input connected to the output of the signal processor and an output for generating an audio signal corresponding to the second electrical signal.



The hearing instrument is further provided with a movement activated switch, operatively connected to the processor, including a sensor and a computer. The sensor senses head movements of the user. The computer compares the movements and validates only those which are specific to the hearing instrument. In use, a user moves his or her head in predetermined patterns. The sensor relays these movements to the computer which compares all of the movements and responds only to those specific to the hearing instrument. Once the movements have been validated and correspond to a predetermined function, the computer sends a fourth electrical signal to the signal processor to perform the function corresponding to the predetermined pattern, such as switching between one program and another, or to switch between one input transducer and another. A method for switching between one program and another or between one input transducer and another is also disclosed. The invention allows a user to take full advantage of programmable hearing instruments.

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HEARING INSTRUMENT WITH HEAD ACTIVATED SWITCH

FIELD OF THE INVENTION

The present invention is a hearing instrument having a head activated switch.

DESCRIPTION OF THE PRIOR ART

Hearing instruments have evolved considerably since their inception. What were once bulky and unsightly hearing instruments are now available in a variety of formats, such as hearing instruments which fit behind a user's ear, or which can be inserted in the ear canal. Recent innovations have also produced what are known as "completely in canal" (hereinafter CIC) hearing instruments, i.e. those which completely fit within the ear canal of a user and thus are very discreet.

Along with these innovations, it is also now possible to tailor the response parameters of a hearing instrument to the specific hearing impediment of the user for whom the instrument is being fitted. Such hearing instruments are generally referred to as being programmable.

There are presently two types of programmable hearing instruments available presently: "analog" hearing instruments, where the response parameters are tailored using analog circuitry for the signal path and digital circuitry for the programming path, and "digital" hearing instruments, where the response parameters are tailored using digital signal processing. The latter hearing instruments may further include a plurality of response parameters within their signal processing means which can be changed by a user.

Furthermore, some hearing instruments provide for manual switching between an omni-directional microphone, a directional microphone or a telephone coil. This switching is usually effected by the user, with a finger, manually activating a switch. In other cases, particularly in the case of

programmable or digital hearing instruments, a user is provided with a wireless remote control, such as infrared or ultrasonic, which can control this switching and may further switch the hearing instrument programming from one program to another, depending on the acoustical environment the user is in.

A disadvantage with the above methods of switching, either microphones or programming, is that the user must either use a finger, which is indiscreet, or carry a remote control, which is impractical. Furthermore, CIC instruments have a very small surface on which to place potentiometers or switches.

U.S. Patent no. 5,553,152 to Newton is an attempt to overcome this problem. This patent discloses an apparatus and method for magnetically controlling a hearing aid, and is particularly directed to a CIC hearing aid. The hearing aid has a plurality of adjustable operational parameters which can be controlled by the movement of an external magnetic actuator (a magnet) into and out of proximity with the hearing aid. In use, the magnetic source is moved into and out of proximity with the hearing aid a selected number of times to activate the magnetic switch each time. This device has the same disadvantage as the manual hearing instruments described above, i.e. it is indiscreet as the user has to physically move a magnet in and out of the ear canal in order to activate the magnetic switch.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a hearing instrument which obviates the above-noted defects in the prior art. In accordance with the invention, this object is achieved with a programmable or digital hearing instrument comprising at least one ambient signal transducer means for receiving ambient signals and generating a first electrical signal in response to the ambient signals, a signal processing means connected to the output of the ambient signal transducer means for processing the first electrical signal and generating a second electrical signal according to one of at least two different sets of response parameters, switch means for selecting the set of response parameters in the signal processing means, and an output transducer means

for generating an audio signal in response to the second electrical signal. The hearing instrument is characterized in that the switch means comprise a switch activated by specific head movements of the user.

The movement activated switch includes a head movement sensing means for generating a third electrical signal, and a computer means for comparing the third signal to at least one stored pattern of head movements and generating a fourth electrical signal forwarded to the signal processing means upon replications of the pattern of head movements by the user. The head movement sensing means senses head movements of the user. The computer means compares the movements with predetermined patterns and validates only those which are specific to the hearing instrument.

In use, a user moves his or her head in predetermined patterns. The sensing means relay these movements to the computer means which analyses all of the movements and responds only to those specific to the hearing instrument. Once the movements have been validated and correspond to a predetermined function, the computer means sends an electrical signal to the signal processing means to perform the function corresponding to the predetermined pattern, i.e. switch between one program or another.

Thus, it can be readily seen that the novel hearing instrument according to the invention has the advantage of not requiring a remote control in order to take advantage of the full potential of the hearing instrument. Furthermore, this hearing instrument obviates the need for manual operation, which can be indiscreet and troublesome, particularly for CIC hearing instruments.

As an example, the head movement sensing means can be of any type such as gravitational, displacement, velocity, acceleration or Hall-effect type and can be omni-directional or directional on one or more directions or even two- or three-dimensional. However, for the purposes of simplicity, it is preferred that the head movements be few and simple so as to not discourage users from taking advantage of the potential of this novel hearing instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention and its advantages will be more easily understood after reading the following non-restrictive description of preferred embodiments thereof, made with reference to the following drawings in which:

Figure 1 is a schematic representation of a hearing instrument according to a preferred embodiment of the invention;

Figures 2a and 2b are a representation of a sensing means for the hearing instrument of Figure 1, in use;

Figure 3 is a representation of another sensing means for the hearing instrument of Figure 1;

Figure 4 is a representation of yet another sensing means for the hearing instrument of Figure 1;

Figure 5 is a schematic representation of the hearing instrument of Figure 1, including a plurality of input transducers;

Figure 6 is a schematic representation of the method for switching between one of a plurality of response parameters in a hearing instrument; and

Fig. 7 is a schematic representation of a two-dimensional matrix for use with a sensing means.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

The invention lies principally in the combination of a switch activated by specific head movements of a user with a traditional hearing instrument. Figure 1 shows schematically a typical hearing instrument 10 comprising at least one ambient transducer means 20 having an input 21 for receiving ambient signals and an output 23 for generating a first electrical signal corresponding to the ambient signals.

The hearing instrument 10 also has signal processing means 30 having at least one input 31 for receiving and processing the first electrical signal to produce a second, processed electrical signal and an output 33 for outputting the second processed electrical signal. The processing means is programmable

through a programming port 35 and is programmed with at least two different sets of response parameters. The signal processing means 30 includes means 37 to switch from one program to another.

The hearing instrument 10 has an output transducer means 40 having an input 41 connected to the output 33 of the signal processing means and an output 43 for generating an audio signal corresponding to the second electrical signal.

In accordance with the invention, the switch means 37 comprise a switch 50 which is activated by specific head movements of the user, operatively connected to the signal processing means 30 through a port 39.

The switch 50 includes a head movement sensing means 51 and a computer means 53. The sensing means 51 senses head movements of the user, generates a third electrical signal corresponding to the head movements. The computer means 53 compares the third signal with predetermined patterns and validates only those which are specific to the hearing instrument 10. The computer means 53 generates a fourth electrical signal which is forwarded to the signal processing means when the third signal corresponds to a predetermined pattern.

In use, a user moves his or her head in predetermined patterns. The sensing means 51 relays these movements through the third electrical signal 53 which compares all of the movements and responds only to those specific to the hearing instrument 10. Once the movements correspond to a predetermined head movement pattern, i.e. a function, the computer means 53 sends a fourth electrical signal to the signal processing means 30 through port 39 to perform the function corresponding to the predetermined pattern.

Thus, it can be readily seen that the novel hearing instrument 10 according to the invention has the advantage of not requiring a remote control in order to take advantage of the full potential of the hearing instrument. Furthermore, this hearing instrument 10 obviates the need for manual operation, which can be indiscreet and troublesome, particularly for CIC hearing instruments.

The movement activated switch sensing means 51 can be of any type

such as gravitational, displacement (angular, such as gyroscopic, or linear), velocity, acceleration or Hall-effect type and can be omni-directional or directional on one or more directions or even two- or three-dimensional. However, for the purposes of simplicity, it is preferred that the head movements be few and simple so as to not discourage users from taking advantage of the potential of this novel hearing instrument 10.

In a preferred embodiment which is for illustration purposes only, the sensing means 51 is a gravitational sensor. Figures 2a and 2b shows such a sensor, comprising a semi-circular hermetically sealed container 60 having a first fixed conductor 61 at the bottom thereof, and a second fixed conductor 63 at the top and around the periphery of the container 60. The container 60 contains a predetermined amount of a substance 65, preferably liquid, that conducts electricity. For example, the substance 65 could be mercury.

The first 61 and second 63 conductors are operatively connected to the computer means 53. In use, when a user tips his or her head by a predetermined amount, as shown on Fig. 2b, the mercury 63 makes contact with the two conductors 61, 63 and closes the circuit. The computer means 53 senses the closing of the circuit and processes the information. For example, the computer means 53 may be programmed to recognize three such closings within a short period of time, indicating that the hearing instrument 10 change the programming from the one presently active to the next one in sequence.

As can be seen, this sensor 51 is omni-directional, in that notwithstanding the orientation of the "tipping", as long as the circuit is closed a predetermined amount of times, or for a predetermined length of time, the computer means 53 will analyze the signal and respond accordingly if the pattern matches one that is stored in the computer means 53.

Alternatively, such a sensing means 51 can be directional, as shown on Fig. 3, where the circuit will be closed only when there is movement along the axis, any other movement failing to close the circuit.

Yet another alternative is shown in Fig. 4, where the sensor there again is directional, but in two perpendicular directions. One of the directions could be for going forward in the programming sequence, whereas the other direction

could be for going backward in the programming sequence.

Yet another alternative is shown in Fig. 7, where the sensing means 51 is gravity type, but on two dimensions. The sensing means 51 is in the shape of a semi-sphere, such as the one on Figs. 2a and 2b, but the container is provided with a matrix of conductors. Thus, when a user moves his or her head, the quantity of mercury makes contact with different conductors. This type of sensor can be particularly beneficial in the case where the hearing instrument 10 is equipped with a directional microphone and an omni-directional microphone. In use, a user may move his or her head, for example, gradually forward, with the result that the sensitivity of the omni-directional microphone decreases in favour of the directional microphone in a desired direction. Such a sensor would be referred to as "analog", since the "zoom" of the directional microphone is proportional to the degree of tilting of the head with respect to the original position.

In a standard hearing instrument 10, the ambient input transducer 20 is usually an omni-directional microphone. However, a hearing instrument can be provided with a directional microphone or a telephone coil, or both as mentioned above. As such, the sensing means 51, and the computer means 53, may be used to switch from one to the other, depending on the configuration of the hearing instrument 10.

In a case where the hearing instrument 10 includes more than one ambient input transducer as shown on Fig. 5, each of the input transducers 20, 20', 20" are operatively connected to a respective input 31, 31', 31" of the signal processing means 30. Furthermore, the signal processing means 30 includes means 39 for switching between one or the other of the input transducers. Accordingly, the computer means 53 is appropriately configured to send a signal to the signal processing means 30 to switch between one or the other of the input transducer 20 in response to a predetermined movement pattern.

The computer means 53 according to a preferred embodiment of the invention is a microprocessor, which, due to advances in miniaturization of such electronic components, can be completely inserted within the hearing instrument in the limited space available. The computer means 53 may also be

provided with a "learning means " 55. This allows for differences in movement between one person and another. For example, a person may execute a predetermined pattern in a very short time, whereas another will take longer to execute the same pattern. As such, the computer means 53 of the hearing instrument can "learn" that a user executes the predetermined pattern in a given manner, and will respond accordingly. It is also possible to conceive a computer means 53 which may itself be programmed with predetermined patterns by a user, instead of having the patterns "hard-wired" by the manufacturer of the hearing instrument and/or the decoder.

In any event, it should be understood that the patterns should be kept simple, and the different movements be kept to a minimum. This encourages users to benefit from the potential of the hearing instrument 10, rather than be discouraged by it due to movements that are too complicated or too conspicuous, particularly when one is in a social context.

Advantageously, the computer means 53 also includes an "enable" and "disable" pattern. Thus, should a user be participating in strenuous physical activity or be in a position where head movements are frequent and uncontrolled, the user may disable the decoding function to avoid having the computer means 53 respond to unintentional movements, and thus accidentally or inadvertently send a code to the signal processing means.

It should be stressed that the invention described herein is not limited to a particular embodiment described, but is concerned with the combination of a hearing instrument with a movement activated switch whereby a user may, upon making predetermined head movements, benefit from the full potential of a programmable hearing instrument, including the possibility to switch between a plurality of input transducers.

Fig. 6 shows the method of switching between one of a plurality of response parameters. The sensing means 51 continuously (if enabled) generate a third electrical signal corresponding to the head movements. The computer means 53 compare the third electrical signal with stored patterns and generates a fourth electrical signal when identity between the third signal and a stored pattern exists. It should be noted that this method is equally applicable

when the hearing instrument is provided with more than one input transducer.

Although the present invention has been explained hereinabove by way of a preferred embodiment thereof, it should be pointed out that any modifications to this preferred embodiment within the scope of the appended claims is not deemed to alter or change the nature and scope of the present invention.

CLAIMS

1. A programmable hearing instrument for use in an ear of a user comprising:

at least one ambient signal transducer means for receiving ambient signals and generating a first electrical signal in response to said ambient signals;

a signal processing means connected to the output of the ambient signal transducer means for processing the first electrical signal and generating a second electrical signal according to one of at least two different sets of response parameters;

switch means for selecting the set of response parameters in the signal processing means; and

an output transducer means for generating an audio signal in response to the second electrical signal,

characterized in that the switch means comprises a switch activated by specific head movements of the user.

2. A programmable hearing instrument according to claim 1, characterized in that the switch means includes a head movement sensing means for generating a third electrical signal, and a computer means for comparing the third signal to at least one stored pattern of head movements and generating a fourth electrical signal forwarded to the signal processing means upon replication of the pattern of head movements by the user.

3. A programmable hearing instrument according to claim 2, characterized in that the stored pattern of head movements are more than one in number, and where the fourth electrical signal is responsive to the replicated pattern of head movements and indicative of the set of response parameters to be selected by the signal processing means.

4. A programmable hearing instrument according to claim 3, characterized

in that said head movement sensing means is a gravitational sensor.

5. A programmable hearing instrument according to claim 3, characterized in that said head movement sensing means is a displacement sensor.

6. A programmable hearing instrument according to claim 3, characterized in that said head movement sensing means is a velocity sensor.

7. A programmable hearing instrument according to claim 3, characterized in that said head movement sensing means is an acceleration sensor.

8. A programmable hearing instrument according to claim 3, characterized in that said switch means further comprises a Hall-effect type sensor.

9. A programmable hearing instrument according to claim 4, characterized in that said sensor comprises a semi-circular, hermetically sealed container having a first fixed conductor at the bottom thereof and a second fixed conductor at the top thereof and around the periphery of said container, said first and second fixed conductors being operatively connected to said decoder, and wherein said container contains a predetermined amount of a liquid, electrically conducting substance.

10. A programmable hearing instrument according to claim 9, characterized in that said liquid, electrically conducting substance is mercury.

11. A programmable hearing instrument according to claim 4, characterized in that said sensor is a U-shaped hermetically sealed container having a first fixed conductor at the bottom thereof and a pair of second fixed conductors at the top thereof, said first and second fixed conductors being operatively connected to said decoder, and wherein said container contains a predetermined amount of a liquid, electrically conducting substance.

12. A programmable hearing instrument according to claim 1, characterized in that said programmable hearing instrument includes at least two ambient signal transducer means, said signal processing being connected to each ambient signal transducer, and said switch means is adapted to further switch between one and the other of said ambient signal transducers in response to a predetermined specific head movement of the user.

13. A programmable hearing instrument according to claim 1, characterized in that said programmable hearing instrument further includes a learning means in order to learn and recognize specific head movements.

14. A programmable hearing instrument according to claim 2, characterized in that said decoder is further programmed with an enable and a disable pattern for enabling and disabling respectively said switch means.

15. A method for switching between one of a plurality of response parameters in a programmable hearing instrument comprising the steps of:

providing a programmable hearing instrument comprising:

at least one ambient signal transducer means for receiving ambient signals and generating a first electrical signal in response to said ambient signals;

a signal processing means connected to the output of the ambient signal transducer means for processing the first electrical signal and generating a second electrical signal according to one of at least two different sets of response parameters;

switch means for selecting the set of response parameters in the signal processing means, said switch means switch means includes a head movement sensing means for generating a third electrical signal, and a computer means for comparing the third signal to at least one stored pattern of head movements and generating a fourth electrical signal forwarded to the signal processing means upon replication of the pattern of head movements by the user; and

an output transducer means for generating an audio signal in response

to the second electrical signal.

16. A method according to claim 15, characterized in that said programmable hearing instrument further comprises at least two ambient signal transducer means and said switch means are adapted to switch between one or the other of the ambient signal transducer means,

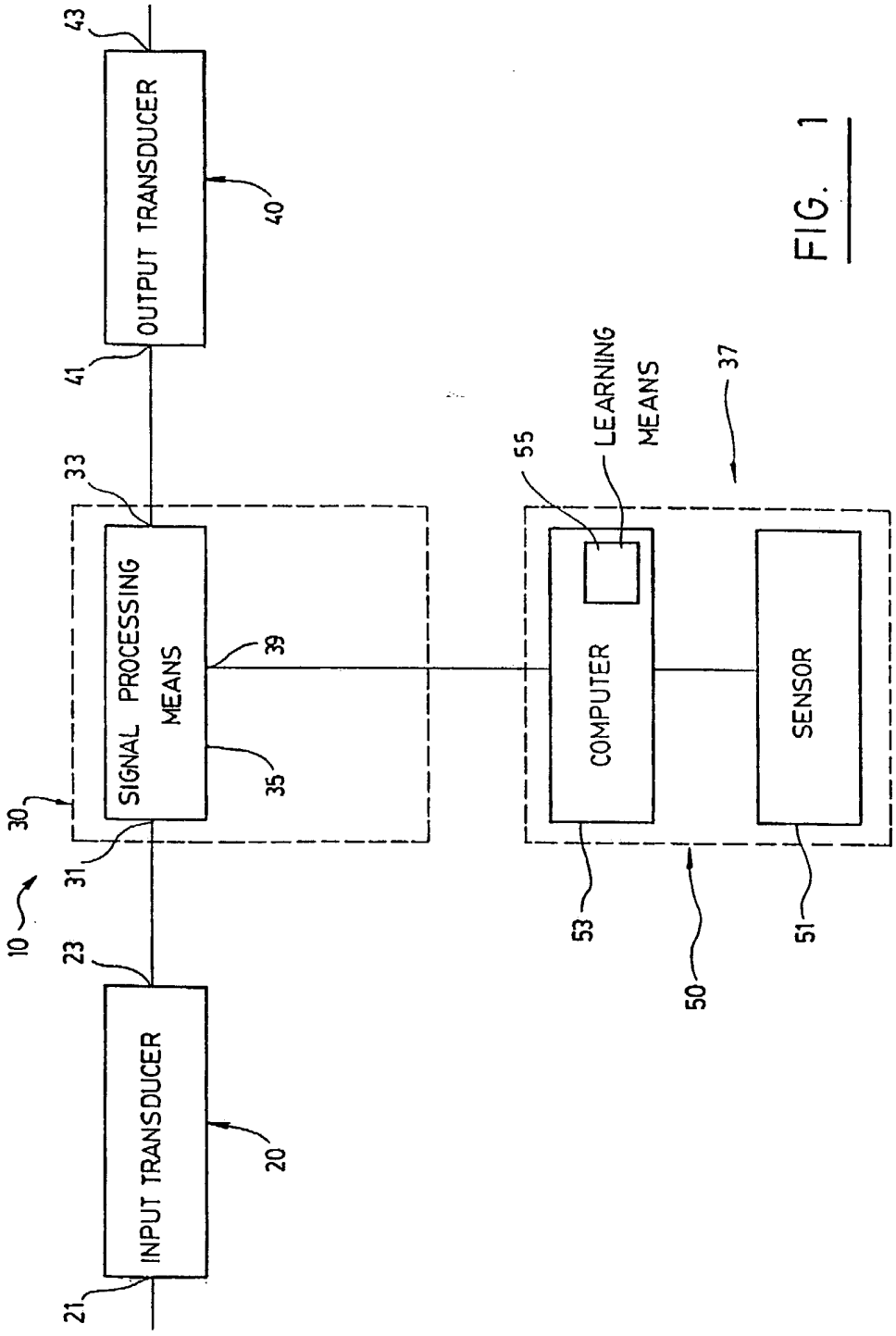
the method comprising the further step of switching between one or the other ambient signal transducer means by moving a user's head in another predetermined head movement pattern.

17. A method according to claim 16, characterized in that said switch means includes a head movement sensing means and a computer means, the method comprising the additional steps of:

generating a third electrical signal in response to head movements, forwarding the third electrical signal to the computer means,

comparing the third electrical signal with at least one predetermined pattern stored in the computer means, and

generating a fourth electrical signal when the third electrical signal corresponds to at least one predetermined pattern.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OUTPUT TRANSDUCER
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41
33
SIGNAL PROCESSING MEANS
39
35
30
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INPUT TRANSDUCER
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LEARNING MEANS
37
COMPUTER
SENSOR
53
50
51

FIG. 1

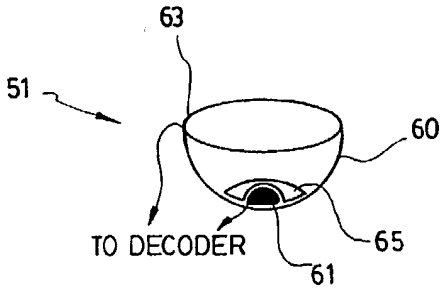


FIG. 2a

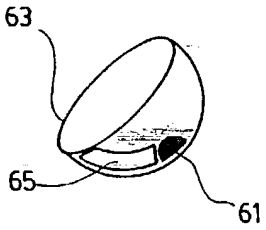


FIG. 2b

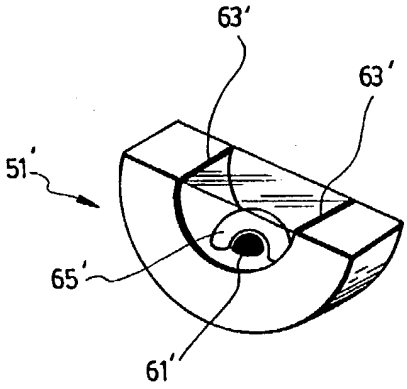


FIG. 3

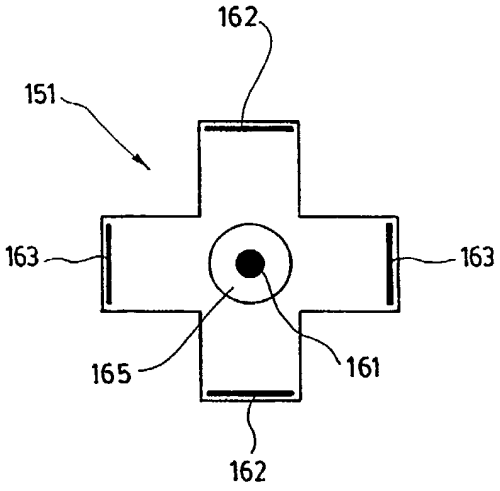
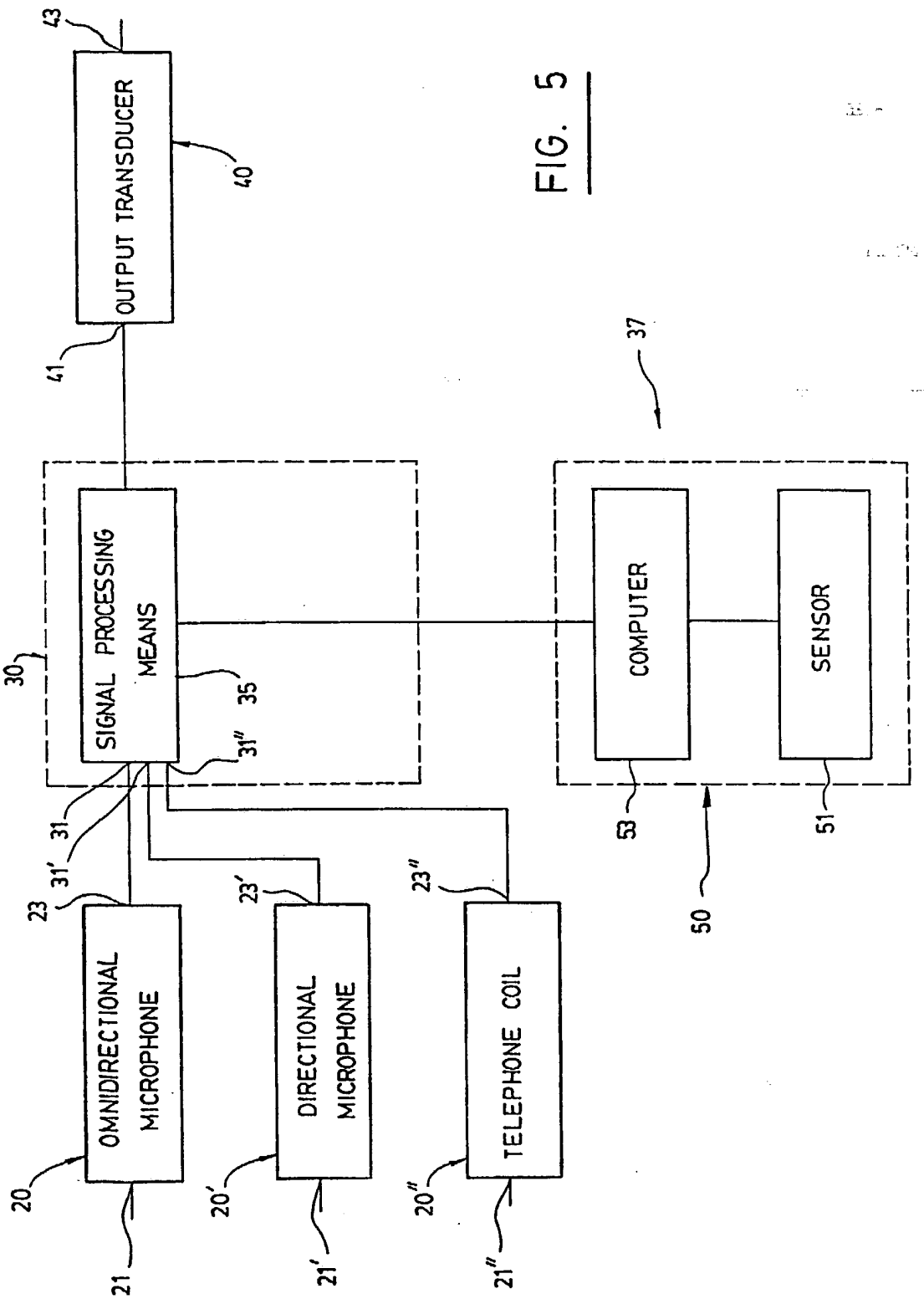


FIG. 4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SIGNAL PROCESSING MEANS
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31
31'
COMPUTER
SENSOR
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51
50
23
23'
23''
OMNIDIRECTIONAL MICROPHONE
DIRECTIONAL MICROPHONE
TELEPHONE COIL
20
20'
20''
21
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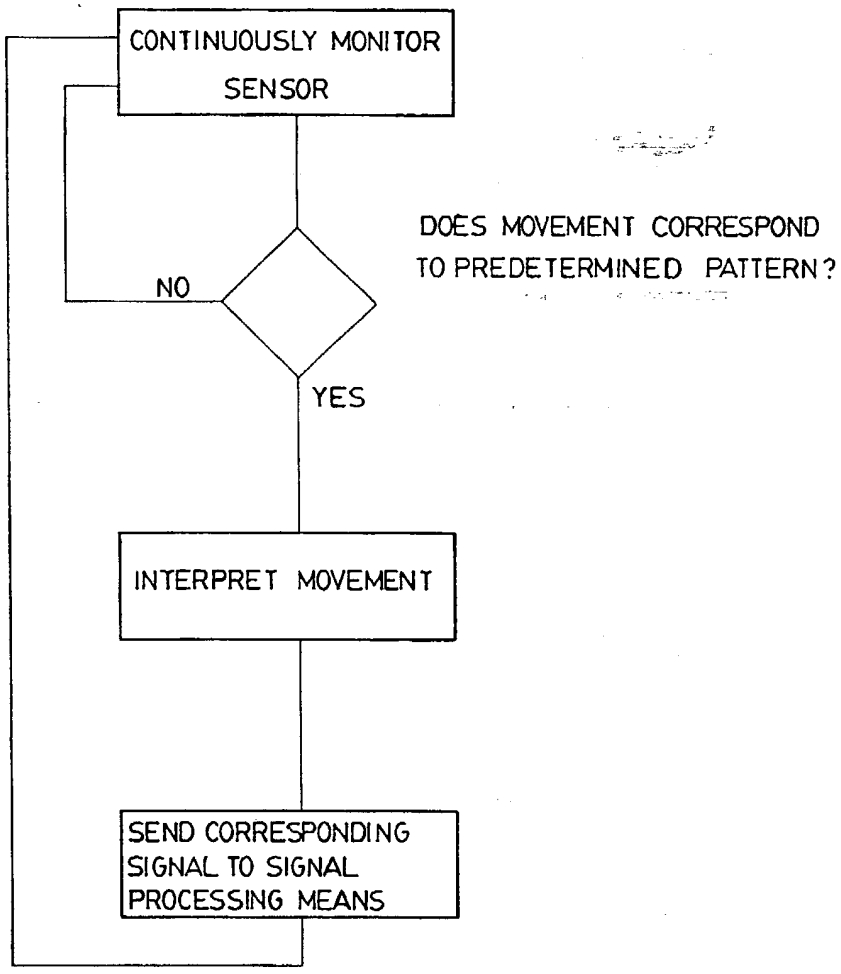
FIG. 5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DOES MOVEMENT CORRESPOND TO PREDETERMINED PATTERN?
NO
YES
INTERPRET MOVEMENT
SEND CORRESPONDING SIGNAL TO SIGNAL PROCESSING MEANS

FIG. 6

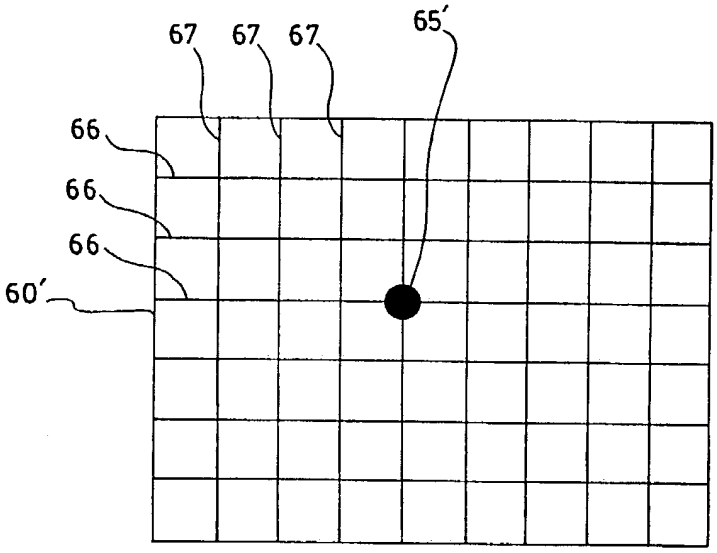

FIG. 7